



Preventing Nerve Damage During Thyroid Surgeries

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Article ID: WMC003260

Article Type: Review articles

Submitted on: 17-Apr-2012, 01:08:33 AM GMT **Published on:** 17-Apr-2012, 12:19:22 PM GMT

Article URL: http://www.webmedcentral.com/article_view/3260

Subject Categories: OTORHINOLARYNGOLOGY

Keywords: Nerve Damage in Thyroid Surgeries, Prevention, Thyroidectomy Complication, Recurrent Laryngeal Nerve Paralysis

How to cite the article: Thiagarajan B, Ramamoorthy G. Preventing Nerve Damage During Thyroid Surgeries . WebmedCentral OTORHINOLARYNGOLOGY 2012;3(4):WMC003260

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Source(s) of Funding:

No external funding was made use of while authoring this article

Competing Interests:

The authors have nothing to declare pertaining to competing interest

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Abstract

Thyroid surgery is a potential risk for vital nerves which include recurrent laryngeal nerve and superior laryngeal nerve. Out of these two damage to recurrent laryngeal nerve leaves the patient with a hoarse voice. Situation is more disastrous if recurrent laryngeal nerve is damaged on both sides during total thyroidectomy. This leads to bilateral abductor paralysis condemning the patient to life long tracheostomy. This article discusses various preventive steps that can be taken while performing thyroidectomies to avoid injury to recurrent laryngeal nerves.

Introduction

Thyroid gland is intimately related to two important nerves that control voice; i.e. Superior laryngeal and recurrent laryngeal nerves. Surgeon who operates on thyroid should always keep in mind the unpleasant morbidity caused by inadvertent injury to these nerves during surgery. Thyroid surgery is one of the commonly performed surgical procedures these days [1]. "Can the thyroid gland when in the state of enlargement be removed...? If a surgeon should be so foolhardy as to undertake it, every step he takes will be environed with difficulty, every stroke of his knife will be followed by a torrent of blood and lucky it would be for him if his victim lives long enough to enable him to finish his horrid butchery. No honest and sensible surgeon would ever engage in it" Samuel Gross 1848. Things have moved a long way since the famous quote of Gross. With the common availability of state of the art haemostats like bipolar cautery, Radiofrequency cautery and harmonic scalpels more and more surgeons are emboldened to venture into this field. It is slowly becoming a border zone where surgeons of various specialities attempt to transgress (General surgeons, otolaryngologists and surgical endocrinologists). Currently available state of the art cautery devices like LigaSure [3]/ Harmonic scalpel [2] have really made surgeons job in securing haemostasis during this surgery real easy. Lot of credit should go to Theodor Kocher who showed that morbidity / mortality can be significantly reduced if meticulous dissection and precise ligation of blood vessels is carried out. Under his hands the mortality

rate came down to less than 1%. He was awarded the Nobel Prize in recognition to his contribution to the knowledge of thyroid gland. After him it was left to Billroth to carry the torch of knowledge further.

Causes for increased morbidity / mortality during thyroid surgeries

1. Haemorrhage
2. Asphyxia
3. Air embolism
4. Infections

Almost all of these have been conquered by innovations in the field of anaesthesiology and surgical instrumentation. Excellent exposure and meticulous haemostasis will go a long way in helping to reduce the complications of thyroid surgery. It is imperative on the part of the surgeon to recognize the potential complications of this surgical procedure and take adequate steps to reduce their incidence in the interest of the patient. Blood less field will help the surgeon to identify vital structures like recurrent laryngeal nerves, parathyroid, and superior laryngeal nerves.

Commonly involved nerves during thyroid surgeries include:

- a. Recurrent laryngeal nerves
- b. Superior laryngeal nerves

Recurrent laryngeal nerves are closely related to the inferior vascular pedicle of thyroid gland (inferior thyroid artery) and superior laryngeal nerves are related to the superior vascular pedicle i.e. superior thyroid vessels. Injuries involving recurrent laryngeal nerves are more sinister in nature and can cause morbidities ranging from aspiration to stridor. Best way to avoid injuries to recurrent laryngeal nerve (more important) of the two is to identify the nerve in all cases [4, 5].

Recurrent laryngeal nerve injury

Recurrent laryngeal nerve injuries are more common in thyroid surgeries performed for:

1. Thyroid carcinoma
2. Toxic goitre – Due to increased vascularity which

obscures the nerve due to excessive bleeding

3. Recurrent goitre – Due to adhesions and anatomical displacements

Clinical features of recurrent laryngeal nerve injuries [6]:

Unilateral recurrent laryngeal nerve injury:

Is the most common situation encountered. Left cord is affected commonly than the right as the left vagus nerve takes a more tortuous course. To start with the voice is breathy, but the normal vocal cord starts to compensate soon. The air way is adequate and there is no stridor in these patients. On indirect laryngoscopic examination the affected cord could assume any of the 6 positions described above. The cord may appear not to move, while the opposite cord will compensate for the lack of mobility.

These patients have a breathy voice. The breathiness of voice is caused by glottic chink which allows air to escape when the patient attempts to speak. Normal voice production is dependent on proper glottal closure resulting from bilateral adduction of the vocal cords. This adduction of vocal folds combined with subglottic air pressure causes the vocal folds to vibrate causing phonation.

Bilateral recurrent laryngeal nerve injury:

This is the most dreaded complication of thyroid surgeries. These patients manifest with stridor and tracheostomy need to be performed in order to secure the airway. This is commonly seen as a sequela to total thyroidectomy. Voice is normal in these patients.

Tips for avoiding injury to recurrent laryngeal nerve during thyroid surgery

1. Detailed anatomical knowledge of recurrent laryngeal nerve and its varying relationships with that of inferior thyroid artery
2. Temptation to mass ligate the pedicles (inferior) especially should be resisted
3. Ligatures should stay as close to the thyroid gland as possible always
4. Recurrent laryngeal nerve should be identified before securing inferior thyroid vessels
5. Haemostasis should be meticulously maintained at all times in order to provide good surgical field for identifying the nerve
6. Indirect laryngoscopy should always be performed before surgery in these patients to know the preoperative vocal cord status
7. First time is the best time for surgery. Always complete / ensure complete removal of the disease

the very first time. Attempts at revision surgery is always fraught with dangers to the recurrent laryngeal nerve.

8. Common site of injury to recurrent laryngeal nerve is close to the Berry's ligament. This can be due to excessive traction, nerve getting caught within ligatures, nerve being injured due to electrocoagulation.

9. A branched recurrent laryngeal nerve is more prone for injury during surgery.

Role of inferior thyroid artery in identifying recurrent laryngeal nerve

Common relationship of recurrent laryngeal nerve to inferior thyroid artery [8]:

The recurrent laryngeal nerve has significant but varying relationship with the inferior thyroid artery. On the left side, the recurrent laryngeal nerve passes behind the inferior thyroid artery in 50% of the cases and anterior to the artery in 20% of cases and may lie in between the branches of the inferior thyroid artery in 30% of cases. On the right side since the recurrent laryngeal nerve approaches the tracheoesophageal groove more laterally, these relations are different on the right side. In half of the cases the recurrent laryngeal nerve passes between the distal branches of the inferior thyroid artery, in 30% of patients it may lie anterior to the artery, and in 20% of cases it may lie deep to the inferior thyroid artery.

Identification of inferior thyroid artery, careful ligation of all its branches close to the gland rather than away from it is very helpful in preventing damage to recurrent laryngeal nerve and inferior parathyroid glands. In rare cases the nerve can branch below the inferior thyroid artery and in this scenario it is safe for the surgeon to assume all these branches to be motor branches to the larynx and take extra care to avoid damage to them. Inferior thyroid artery (a branch from the thyrocervical trunk) appears from beneath the carotid sheath only when the thyroid gland is retracted medially and the jugular vein retracted laterally. This manoeuvre puts strain in the artery and helps in better visualization. Before entering the thyroid gland it divides into three branches inferior, posterior and internal. This artery also supplies the inferior parathyroid gland.

Relationship of recurrent laryngeal nerve to Berry

Also known as suspensory ligament of Berry. This ligament attaches the postero medial aspect of thyroid gland to the sides of cricoid cartilage and first two tracheal rings. It is this very attachment that is responsible for the up and down mobility of thyroid gland which occurs during swallowing.

This is a rather crucial area. The recurrent laryngeal nerve is embedded close to the posterior portion of Berry's ligament and is prone for injury when this ligament is sectioned in order to free the gland from its attachment. Inferior laryngeal artery lies posterior to recurrent laryngeal nerve in this area. Bleeders from Berry's ligament should not be clamped blindly before identifying recurrent laryngeal nerve

At the level of middle third of thyroid gland the recurrent laryngeal nerve is situated close to the capsule of the gland. In cases with pathological enlargement of thyroid glands this nerve may be enclosed within the thyroid capsule itself before entering the larynx. It is more prone for injury in large swellings involving thyroid gland.

Medial retraction of thyroid lobe makes the nerve more vulnerable during thyroid surgeries. This maneuver stretches the inferior thyroid artery and its branches displacing the nerve anteriorly in the tracheo oesophageal groove exposing it to danger.

Cricothyroid joint as a marker for the location of recurrent laryngeal nerve

The recurrent laryngeal nerve enters the larynx deep to the inferior constrictor muscle and posterior to the cricothyroid joint. Inside the larynx it divides into a sensory and motor branches. The anteriorly directed motor branch is made up of 1000 axons. About 250 of the axons innervate the cricothyroid muscle, since it is the sole abductor of the vocal fold. The trachea, oesophagus and pyriform sinuses receive their sensory fibers from the posterior division of the recurrent laryngeal nerve before entering the larynx.

Impact of vascular compromise to recurrent laryngeal nerve

Recurrent laryngeal nerve can also be damaged if its blood supply is compromised during surgery. The blood supply to the recurrent laryngeal nerve comes from the inferior thyroid artery. The feeding branches are usually anterior to the nerve. Distally, the inferior

laryngeal artery, a terminal branch of the inferior thyroid artery, supply the recurrent laryngeal nerve. It is always prudent to ligate the inferior thyroid artery closer to the gland after it has given off the branch to the recurrent laryngeal nerve.

Consider non recurrent laryngeal nerve

Non recurrent laryngeal nerve arises directly from vagus nerve in the neck. Hence it is not found in the usual position (i.e. Close to the inferior thyroid artery). Non recurrent laryngeal nerve is a very rare anomaly more common on the right side (0.5-0.6%) [9]. It is extremely rare on the left side (0.004%). At present there is no way of identifying this anomaly preoperatively with acceptable degree of accuracy. If CT scan neck shows retro oesophageal subclavian artery then this condition should be suspected [10].

Use of operating loupe

Operating loupes with at least 4 times magnification with a good working distance is a real boon to the head and neck surgeon while performing thyroid surgeries. Routine use of operating loupes will minimize risk to the recurrent laryngeal nerve during thyroid surgeries.

Superior laryngeal nerve [11]:

This nerve is also prone for injury during thyroid surgeries.

Anatomically superior laryngeal nerve is one of the branches of vagus nerve. Paralysis involving this nerve is frequently overlooked because of complex clinical picture. Functionally speaking the superior laryngeal nerve function can be divided into sensory and motor components. The sensory function provides a variety of afferent signals from supraglottic larynx. Motor function involves motor supply to ipsilateral cricothyroid muscle.

Role of cricothyroid muscle on phonation:

- * Contraction of cricothyroid muscle tilts the cricoid lamina backward at the cricothyroid joint causing lengthening, tensing and adduction of vocal folds causing an increase in the pitch of the voice generated.
- * Diagnosis of superior laryngeal nerve paralysis is based largely on symptomatology and clinical suspicion.

Symptoms:

1. Raspy voice
2. Voice fatigue
3. Volume deficit
4. Loss of singing volume

Kierner classified the superior laryngeal nerve into 4 types depending on the relationship of its external branch to the superior pole of thyroid gland.

Type I nerve: In this type the external branch of superior laryngeal nerve crosses the superior thyroid artery about 1cm above the superior pole of thyroid gland.

Type II nerve: In this type the external branch of superior laryngeal nerve crosses the superior thyroid artery within 1 cm of the superior pole of thyroid gland.

Type III nerve: In this type the external branch of superior laryngeal nerve crosses the superior thyroid artery under cover of the superior pole of thyroid gland.

Type IV nerve: In this type the external branch of superior laryngeal nerve descends dorsal to the superior thyroid artery and crosses its branches just superior to the upper pole of thyroid gland.

Awareness of these anatomical variations will help the surgeon in preserving this branch during head and neck surgeries.

Superior laryngeal nerve is highly vulnerable during ligation of superior pedicle of thyroid gland. Routine identification of this nerve is rather difficult without dissecting through pharyngeal constrictors. In nearly 20% of cases it is not located close to the ligation point of superior pole of thyroid at all. Hence routine identification of this nerve during thyroid surgery has not been advocated. It is safe to ligate superior thyroid artery as close to the superior pole of thyroid gland as possible. It is infact safer to identify the branches of superior thyroid artery and avoid ligating the main trunk as in majority of cases superior laryngeal nerve lies rather close to the main trunk.

Use of nerve monitors

Eventhough nerve monitors and stimulators have been advocated their usefulness still remains highly questionable. One study reports that they were able use it only to identify superior laryngeal nerve. It did not actually aid in the anatomical dissection of recurrent laryngeal nerve [12].

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Illustrations

Illustration 1

This figure shows left recurrent laryngeal nerve paralysis



Illustration 2

Figure showing Berry's ligament and its relationship with recurrent laryngeal nerve

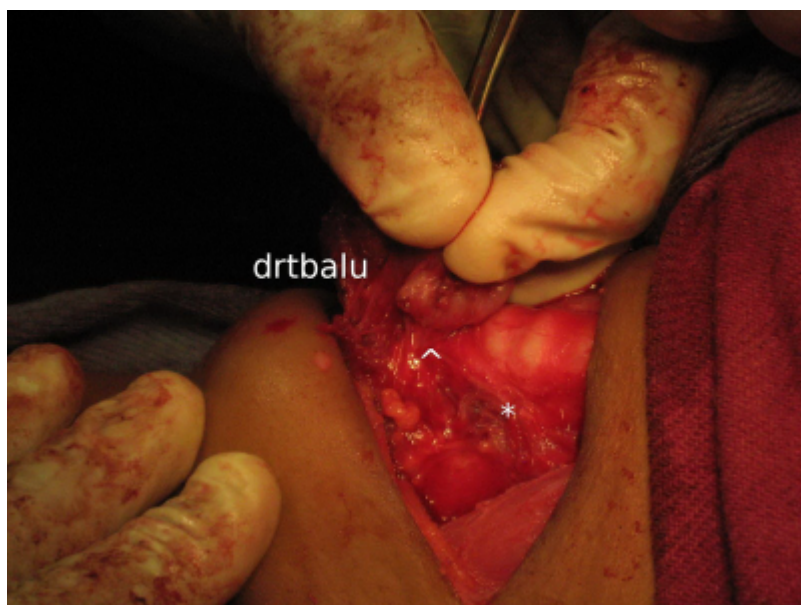


Illustration 3

Picture showing inferior thyroid artery and its branches

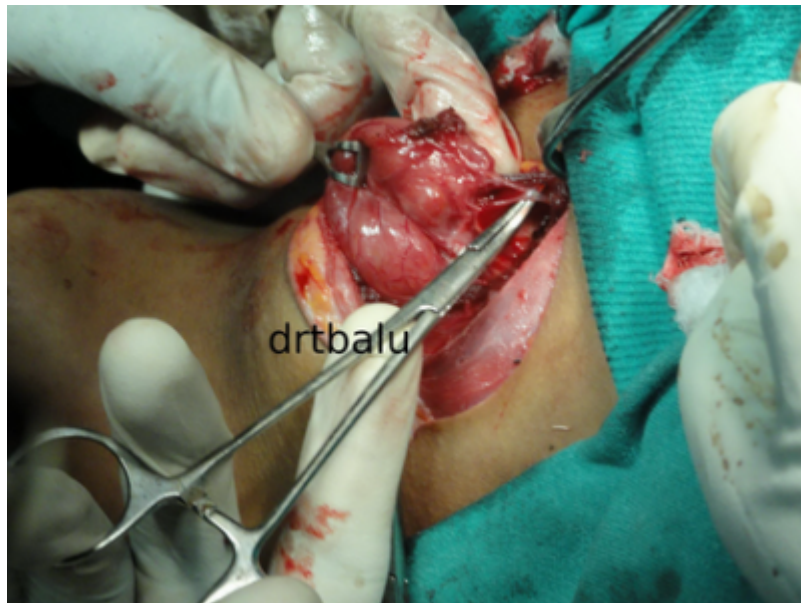
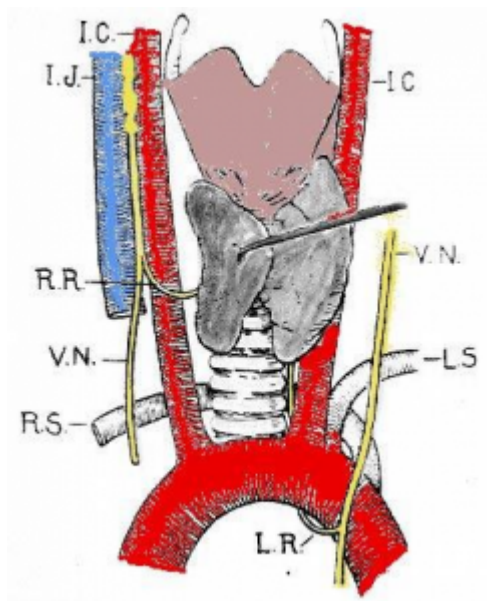


Illustration 4

Figure showing non recurrent laryngeal nerve



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